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Scaling of normal Reynolds stresses in ZPG turbulent boundary layers HASSAN M. NAGIB, KAPIL A. CHAUHAN, IIT, USA, PETER A. MONKEWITZ, EPFL, Switzerland — An extensive set of experimental data for zero pressure gradient (ZPG) boundary layers over a wide range of Reynolds number is re-evaluated in another attempt to reveal appropriate scaling of the turbulence normal stresses. In view of the lack of well developed theoretical foundations for even the second- order statistics, the task is complex, and rigorous theoretical arguments cannot be made in favor of any of the commonly used non-dimensionalizatios; namely, inner, outer or mixed velocity scales. While the correlation of the data reveals some interesting and sometime contradicting trends, the limitations on measurement accuracy and spatial resolution, particularly in the near wall region, prevent us from reaching definitive conclusions. However, examining the role of the normal Reynolds stress difference (NSD) term in the Kármán integral equation using recent results from asymptotic theory suggests that the outer velocity scaling is likely not correct, in spite of the better collapse of the available data it produces in the outer part of the boundary layer. While the NSD must be included in any large Reynolds number asymptotics, we conclude that, for any practically relevant Reynolds number, the NSD integral in the Kármán equation represents a small correction which can be neglected as it has been done up to now.

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